PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : G06K 19/07, 7/10, 7/00 — A1

(11) International Publication Number: WO 00/16253

(43) International Publication Date: 23 March 2000 (23.03.00)

(21) International Application Number: PCT/EP99/06674

(22) International Filing Date: 9 September 1999 (09.09.99)

(30) Priority Data:
TO98A000780 15 September 1998 (15.09.98) IT

(71) Applicant *(for all designated States except US)*: URMET COSTRUZIONI ELETTRO-TELEFONICHE S.P.A. [IT/IT]; Via Bologna, 188/c, I-10154 Torino (IT).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: MONDARDINI, Massimo [IT/IT]; Via Mazzini, 40, I-10123 Torino (IT).

(74) Agent: MODIANO, Guido; Spandonari & Modiano, Corso Duca degli Abruzzi, 16, I-10129 Torino (IT).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

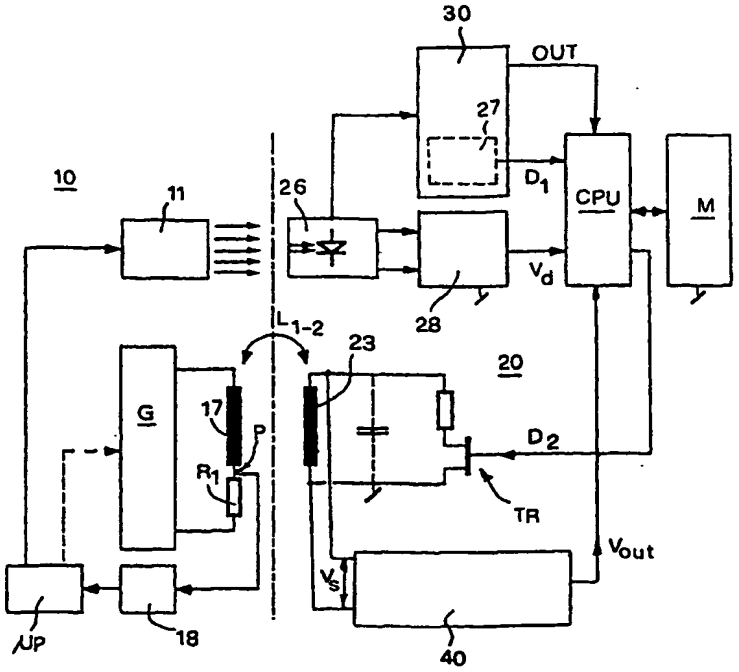
With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: A SYSTEM FOR CONTACTLESS BIDIRECTIONAL TRANSMISSION OF DATA AND POWER BETWEEN A READER AND A CHIP-CARD, PARTICULARLY FOR TELEPHONY APPLICATIONS

(57) Abstract

A system for contactless bidirectional transmission of data and power between a reader and a chip-card, comprising a first optical path for transmission of data and power with a light source (11) on the reader (10), a photodiode (26) and a control logic unit (CPU) on the chip-card (20), and a second magnetic path for transmission of data and power with a first inductor coil (17) on the reader (10) and a second induced coil (23) on the chip-card (20). According to the invention, a first auxiliary circuit (30) is also provided, which resides in the chip-card (20), has a data demodulation function and is sensitive to the simultaneous presence of the data item signal (Se) and of a minimum level (Vk) of the light signal received by the photodiode (26), as well as a second auxiliary circuit (40) which also resides in the chip-card (20) and is adapted to provide a frequency signal (V_{OUT}) which is proportional to the intensity of the voltage (Vs), generated by induction and present across the second induced coil (23).



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

A SYSTEM FOR CONTACTLESS BIDIRECTIONAL TRANSMISSION OF DATA AND POWER BETWEEN A READER AND A CHIP-CARD, PARTICULARLY FOR TELEPHONY APPLICATIONS

Technical Field

The present invention relates to a system for contactless bidirectional transmission of data and power between a reader and a chip-card, particularly for telephony applications.

Background Art

More specifically, the present invention relates to a system of the type disclosed in prior WO 98/33139 by this same Applicant, which comprises a first optical path for the transmission of power and data from the reader to the chip-card and a second magnetic path mainly for data transmission which is active at least in the card-to-reader direction.

In a system of this type, the first optical path includes a light source which is associated with the reader and is directly or indirectly modulated by the data to be transmitted to the micromodule of the card, which is provided with light receiving means, hereinafter termed input photodiode for the sake of brevity, which are adapted both to convert light energy into electric power for supplying said micromodule and to demodulate the received light beam or beams in order to extract the transmitted information.

The second magnetic path is constituted by a primary coil, which resides in the reader and through which a primary AC current is circulated, and by a secondary coil, which resides in the micromodule of the card and magnetically couples, by mutual inductance, with the primary coil, becoming the seat of a secondary induced current whose variation, generated by modulation means which reside in said micromodule of the card, produces corresponding variations in the primary current used to transmit to the reader the data that reside in the memory or memories of said micromodule of the card.

In the practical embodiment of that conventional system, the

micromodule is substantially embedded in the support that constitutes the card, which is typically made of polymeric material, particularly polycarbonate, and is transparent to light at least at said micromodule but preferably also at an annular region which peripherally surrounds said micromodule.

It is easily understandable that transparency of the support of the card at the region that includes the micromodule is a critical parameter for the correct operation of the system, since the amount of light energy transmitted from the reader to the card depends on this transparency and therefore ultimately on the structural characteristics of the support and there is a minimum threshold value below which the transmitted energy is insufficient.

Accordingly, both during the initial testing of new chip-cards and during the testing of the residual functionality of worn cards it is important to know and measure the amount of light energy that actually reaches the micromodule of the card for a preset intensity of the light source associated with the reader, rejecting cards in which the light energy transmitted to the micromodule does not exceed said preset minimum threshold due to manufacturing defects or to excessive wear.

Disclosure of the Invention

The aim of the present invention is to improve the chip-cards used in the conventional above-specified transmission system, by providing them with auxiliary circuit means adapted to detect and measure the amount of light energy actually transmitted from the reader to the micromodule of the card.

The invention also has the object of providing auxiliary circuit means which are sensitive to the presence of a minimum level of light on the micromodule of the card while receiving the information transmitted by the first channel of the system and are suitable, in the absence of light, to lock the received data and the operation of the card in order to provide a physical fraud-prevention barrier.

In conventional transmission systems of the specified type it is also convenient to know and measure, both for testing the card and for checking how the card and/or the reader is operating, the voltage across the terminals of the power supply circuit of the micromodule of the card and therefore any electric power transferred, by means of the second magnetic path, from the reader to the card.

Another important object of the present invention is to improve the chip-cards of the above-specified conventional systems, by providing them with an additional auxiliary circuit which is connected to the secondary coil of the card and is capable of providing, if activated, a signal related to the intensity of the voltage across the coil, such signal being usable both for initial testing and for optional self-adjustment of the magnetic power transmission circuits.

According to the present invention, this aim, these important objects and others which will become apparent hereinafter are achieved by a system for contactless bidirectional transmission of data and power having the specific characteristics stated in the appended claims.

Substantially, according to the present invention, a first improvement is provided which consists of the fact that the card is provided with first auxiliary circuit means in which the light signal, acquired and transduced into an electrical signal by the input photodiode, flows for demodulation into three separate circuit branches which respectively include: a low-pass filter, which provides an average value of the signal; a peak detector, which returns the peak value of the signal; and a first operational amplifier acting as data item detector, which is adapted to compare the electric input signal with a "data item switching" signal produced by the sum of the average signal and of a fraction of the peak signal, whose value self-adjusts in relation to the intensity of the input signal. The output of the first operational amplifier is connected to one of the inputs of an AND logic gate whose positive logic state in output represents the demodulated useful data

item. The other input of the gate is connected to a second operational amplifier which acts as a detector of the presence of a minimum value of light and compares the average value of the signal with a constant reference value; the first operational amplifier being adapted to switch its output to the logic level "1" when the input signal drops below the level of the data item switching signal. The second operational amplifier being adapted to switch its own output to the logic level "1" when the average value of the signal exceeds the reference value, said logic gate being adapted to switch its output to the logic level "1" when the first operational amplifier detects the presence of the data item and at the same time the second operational amplifier detects the presence of the minimum level of the light signal received by the input photodiode.

Another improvement according to the present invention consists of the fact that the card is provided with second auxiliary circuit means which include two capacitors which are charged alternately by respective current sources which are subjected to the power supply voltage generated by induction across the secondary coil that resides in the card. Switching means are provided in order to alternately discharge the capacitors and accordingly switch the output signal of a multivibrator whose frequency constitutes the useful data item for measuring said supply voltage and is therefore a function of the charging time of the capacitors, which is in turn variable according to the supply voltage applied to said current sources.

Brief Description of the Drawings

Further characteristics and advantages of the contactless transmission system according to the present invention will become apparent from the following detailed description and with reference to the accompanying drawings, given by way of non-limitative example, wherein:

Figure 1 is an electrical block diagram of the transmission system according to the present invention;

Figure 2 is a detailed block diagram of the first auxiliary circuit means

for simultaneously detecting the data item and the minimum level of the light signal;

Figure 3 is a detailed block diagram of the additional auxiliary circuit adapted to provide a signal related to the intensity of the voltage applied across the secondary coil that resides in the card;

Figure 4 is a diagram of the signals processed in the auxiliary circuit of Figure 3.

Ways of carrying out the Invention

Initially with reference to Figure 1, the reference numeral 10 generally designates a chip-card reader, for example associated with a public telephone, and the reference numeral 20 designates a chip-card which comprises, in a per se known manner, a support made of transparent polymeric material, typically polycarbonate, and a chip or micromodule which is embedded or in any case included in the material of the support.

The reader 10 has, in a known manner, a modulated light source 11, a primary coil 17 arranged in series to a resistor R_1 and a source G of AC current at a preset frequency, in which one terminal is connected to the primary coil 17 and the other terminal is connected to the resistor R_1. A detector 18, connected to the coil 17 in the partition point P, demodulates the current that circulates in the coil, detecting the pulsed signal which constitutes, as mentioned hereafter, the data item transmitted from the card 20 to the reader 10. The pulsed signal is processed by a microprocessor μP. The card 20 in turn includes in a known manner a light receptor unit 26, designated as input photodiode for brevity, a light demodulator 27 and a unit 28 for filtering and adjusting the voltage produced by the photodiode 26. The demodulator 27 has a data output D_1 (and an optional clock output) which is connected to a corresponding input of a control logic unit CPU. The control logic unit is operatively connected to a memory unit M and controls, by means of its output D_2, a logic-state modulation transistor TR. The transistor is provided in order to short-circuit, with a fixed impedance, a

secondary coil 23 which resides in the card and is magnetically coupled, by mutual inductance L_{1-2}, to the primary coil 17 of the reader, in which it generates, by virtue of the modulation produced by the transistor TR, the pulsed signal that constitutes the transmitted data item.

Substantially, and in a per se known manner, the light source 11 and the photodiode 26, with the respective circuits and the logic unit CPU, define a first optical path for the transmission of power and data, whilst the coils 17-23 with the source G and the transistor TR define a second magnetic path for the transmission of power and data.

According to the present invention and for the stated purposes, the input photodiode 26 is connected to first auxiliary circuit means, generally designated by the reference numeral 30 in the diagram of Figure 1. Such means include the demodulator 27 and have, in addition to the data output D_1, an additional output OUT which is operatively connected to the logic unit CPU, for which the additional output acts as a disable or enable control, as described hereinafter.

With reference now to the diagram of Figure 2, it can be seen that the first circuit means 30 comprise, as regards demodulation, three separate circuit branches 30a-30b-30c in which the electrical signal Se produced by the photodiode 26 flows.

The first circuit branch 30a includes a low-pass filter 31 which supplies, at its output, an average value Sem of the signal Se. The second circuit branch includes a peak detector 32 which returns the peak value Sep of the signal Se, followed by a fractional multiplier 33 which takes a portion of the peak signal, typically 2/3, and inverts its sign. An adder 34 adds the average value of the signal to the peak value fraction in order to produce a signal Scd which is termed data item switching signal and whose value self-adjusts in relation to the intensity of the signal Se, providing a continuous indication of the signal (memory effect).

A first operational amplifier A_1, acting as data item detector, compares

the electrical input signal Se that arrives from the photodiode 26 with the data item switching signal and switches its own output UA_1 to the logic level "1" when the input signal Se drops below the data item switching signal Scd.

As clearly shown in Figure 2, the output UA_1 of the operational amplifier A_1 is connected to the first input of an AND-type logic gate 35 which has a second input operatively connected to the output UA_2 of a second operational amplifier A_2 which acts as a detector of the presence of a minimum level of light.

For this purpose, the amplifier A_2 receives on one input the average value Sem of the signal and on the other input a constant reference voltage produced by a source Vk. The amplifier A_2 compares the signal Sem with the reference voltage Vk and switches its own output to the logic level "1" when the average value Sem exceeds the reference voltage.

In turn, the gate 35 switches its own output D_1 to the level "1", providing the demodulated useful data item, when both of its inputs are at the level "1", i.e., when the first operational amplifier A_1 detects the presence of the data item and at the same time the second operational amplifier A_2 detects the presence of the minimal level of the light signal received by the photodiode 26.

The presence of the logic level "1" on the output OUT of the circuit means 30 is used to provide the logic unit CPU with an enable signal, whilst the logic level "0" constitutes a disable signal for the logic unit.

According to another characteristic of the improved system according to the present invention, the secondary voltage Vs, generated by induction and present across the secondary coil 23, is sent to second auxiliary circuit means 40 which are capable of supplying, on their output and for the stated purposes, a signal V_{OUT} in terms of frequency which is proportional to the intensity of the voltage Vs.

For this purpose, the second auxiliary circuit 40 comprises (Figure 3)

two current sources 41-42 to which said voltage Vs is applied and which provide in output respective currents I_1-I_2 which are directly proportional to the voltage Vs. The outputs of the generators 41-42 are connected to respective capacitors C_1-C_2 in parallel to which there are provided corresponding electronic switches 43-44 which are controlled by the outputs Q and $\overline{Q}$ of a multivibrator 45 which is controlled by the actions of a first operational amplifier A_3 and a second operational amplifier A_4 which act as comparators. The amplifiers A_3-A_4 receive on one input a reference voltage Vref and receive on the other input the charging voltage that is present across the capacitor C_1 and the voltage present across the capacitor C_2, respectively.

The operation of the auxiliary circuit 40 is as follows: the current I_2 charges the capacitor C_2 until the value Vref is reached (Figure 4); this condition causes the switching of the comparator A_4, whose output sets the multivibrator 45, switching the output signal Q of the latter. The signal Q closes the switch 44, producing the immediate discharge of the capacitor C_2. Simultaneously, the corresponding signal $\overline{Q}$ on the other output of the multivibrator causes the switch 43 to open and consequently causes the capacitor C_1 to charge; this condition continues until the value Vref is reached, causing the switching of the comparator A_3. The output of the comparator resets the multivibrator 45, causing the switching of the output signal Q and the beginning of a new cycle (Figure 4). By increasing the voltage Vs across the secondary coil 23, the charging time of the capacitors C_1-C_2 decreases and the frequency of the signal V_{OUT} present at the output of the circuit 40 correspondingly increases; viceversa, by decreasing the voltage Vs the frequency of the signal V_{OUT} also decreases.

In accordance with the stated aim and objects, the signal V_{OUT} can be sent to the logic unit CPU of the card in order to enable or disable its operation and can also be retransmitted to the reader 10, for example in order to provide a signal for the rejection of the card during initial testing

and/or in order to automatically increase the power transmitted from the reader 10 to the card 20 over the second magnetic path of the system.

Without altering the principle of the invention, the details of execution and the embodiments may of course be altered extensively with respect to what has been described and illustrated by way of non-limitative example without thereby abandoning the scope of the invention.

The disclosures in Italian Patent Application No. TO98A000780 from which this application claims priority are incorporated herein by reference.

CLAIMS

1. A system for contactless bidirectional transmission of data and power between a reader (10) and a chip-card (20), comprising a first optical path for transmission of data and power with a light source (11) on the reader (10), a photodiode (26) and a control logic unit (CPU) on the chip-card (20), and a second magnetic path for transmission of data and power with a first inductor coil (17) on the reader (10) and a second induced coil (23) on the chip-card (20), characterized in that it comprises first auxiliary circuit means (30) which reside in the chip-card (20), have a data demodulation function and are sensitive to the simultaneous presence of the data item signal (Se) and of a minimum level (Vk) of the light signal received by said photodiode (26), and second auxiliary circuit means (40) which also reside in the chip-card (20) and are adapted to provide a frequency signal (V_{OUT}) which is proportional to the intensity of the voltage (Vs), generated by induction and present across the second induced coil (23).

2. The system according to claim 1, characterized in that said first auxiliary circuit means (30) have an output (D_1) of the demodulated data and an additional output (OUT) which disables or enables said logic control unit (CPU) of the chip-card (20).

3. The system according to claim 1, characterized in that said first auxiliary circuit means (30) comprise three separate circuit branches (30a-b-c) which respectively comprise: a low-pass filter (31), a peak detector (32), a fractional multiplier (33) and an adder (34) which, by adding the average value to a fraction of the peak value with its sign changed, generates a data item switching signal (Scd), and in that said data item switching signal (Scd) is compared with the input signal (Se) by a first operational amplifier (A_1) which acts as data item detector and in which the output (UA_1) is connected to the first input of a logic gate (35) whose output (D_1) provides the demodulated data item and whose second input is connected to an output (UA_2) of a second operational amplifier (A_2) which acts as a detector

of the presence of a minimum light level and compares an average value (Sem) of the input signal with a constant reference voltage (Vk).

4. The system according to claim 3, characterized in that said output (UA_2) of the second operational amplifier (A_2) coincides with said additional output (OUT) of the auxiliary circuit means (30).

5. The system according to claim 3, characterized in that the first operational amplifier (A_1) acting as data item detector switches its own output to the logic level "1" when said input signal (Se) drops below the level of the data item switching signal (Scd), in that the second operational amplifier (A_2) switches its own output to the logic level "1" when the average value of the signal (Sem) exceeds said reference value (Vk), and in that said logic gate (35) of the AND type switches its own output (D_1) to the logic level "1", providing the demodulated useful signal, when:

a) the first operational amplifier (A_1) detects the presence of the data item, switching its output to the logic level "1" and simultaneously

b) the second operational amplifier (A_2) detects the presence of a minimum light level and also switches its output to the logic level "1".

6. The system according to claim 1, characterized in that said second circuit means (40) comprise two current sources (41-42) to which said voltage (Vs) present on the secondary coil (23) is applied, said sources providing in output respective currents (I_1-I_2) which are directly proportional to said voltage and produce the charging of respective capacitors (C_1-C_2); discharging means (43-44, A_3-A_4, 45) sensitive to a reference voltage (Vref) being provided in order to produce the alternate discharge (VC_1-VC_2) of said capacitors and correspondingly generate said frequency signal (V_{OUT}) whose frequency is proportional to said voltage (Vs).

7. The system according to claim 6, characterized in that said discharging means comprise electronic switches (43-44) which are arranged in parallel to the respective capacitors (C_1-C_2) and are alternately closed and opened by

the switched outputs (Q-$\overline{Q}$) of a multivibrator (45) which is controlled by a first operational amplifier (A_3) and a second operational amplifier (A_4); which act as comparators and receive said reference voltage (Vref) on one input and the charging voltage of said respective capacitors (C_1-C_2) on another input.

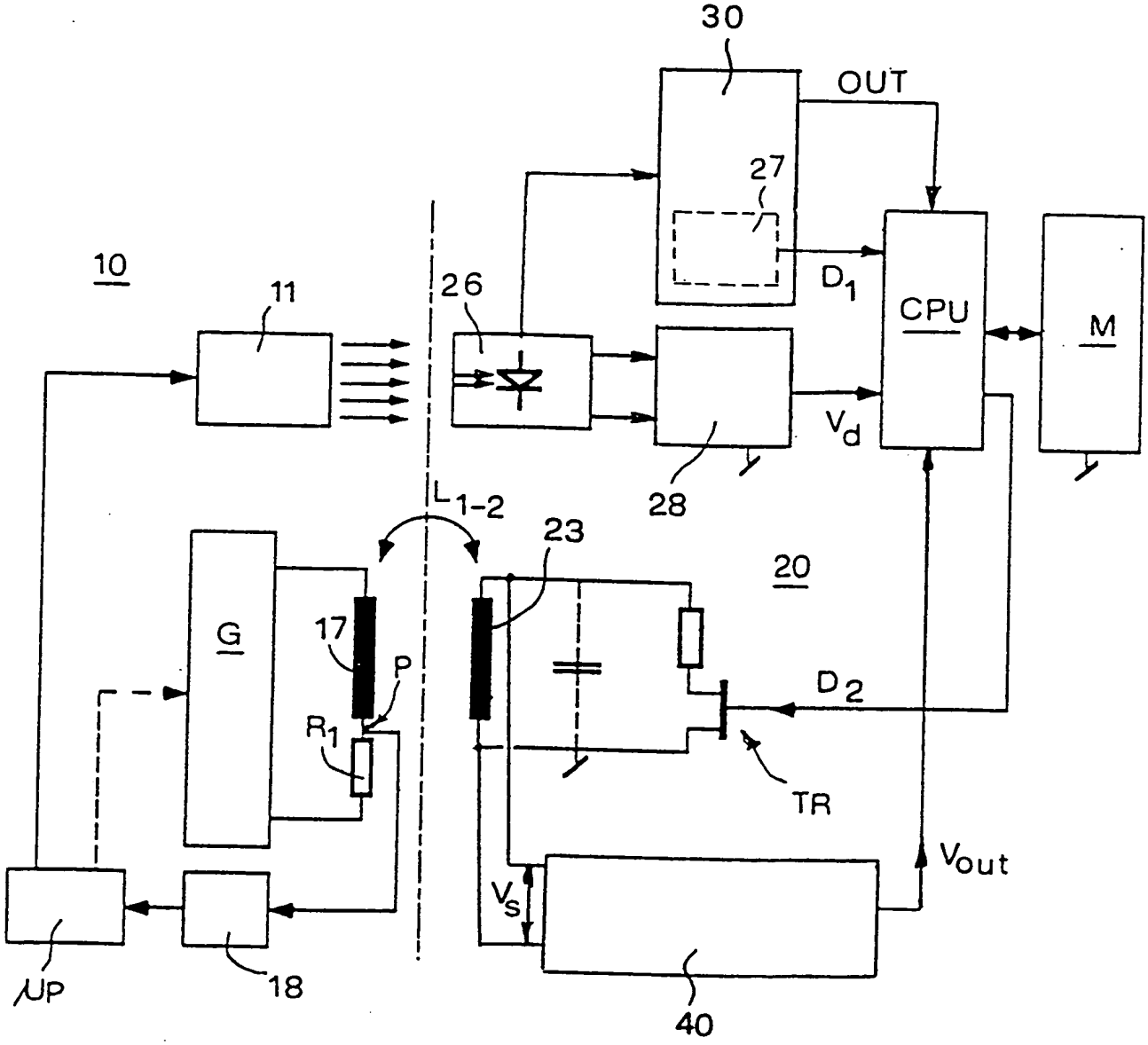

30
OUT
27
10
11
26
D1
CPU
M
Vd
28
L1-2
23
20
G
17
P
R1
D2
TR
Vout
Vs
UP
18
40

Fig. 1

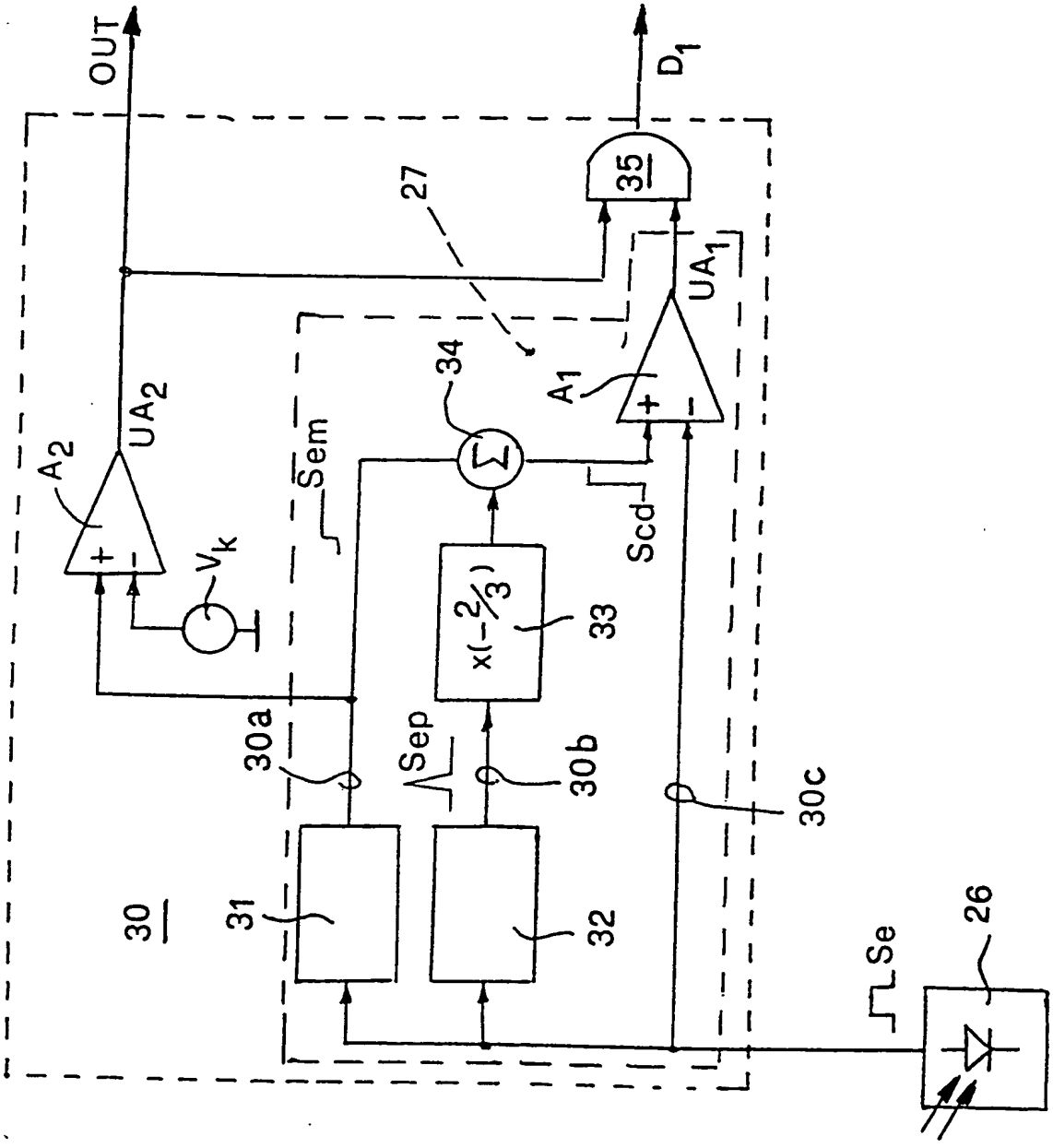

OUT
D1
35
27
UA1
A1
34
UA2
A2
Sem
Vk
Scd
x(-2/3)
33
30a
Sep
30b
30c
30
31
32
Se
26

Fig. 2

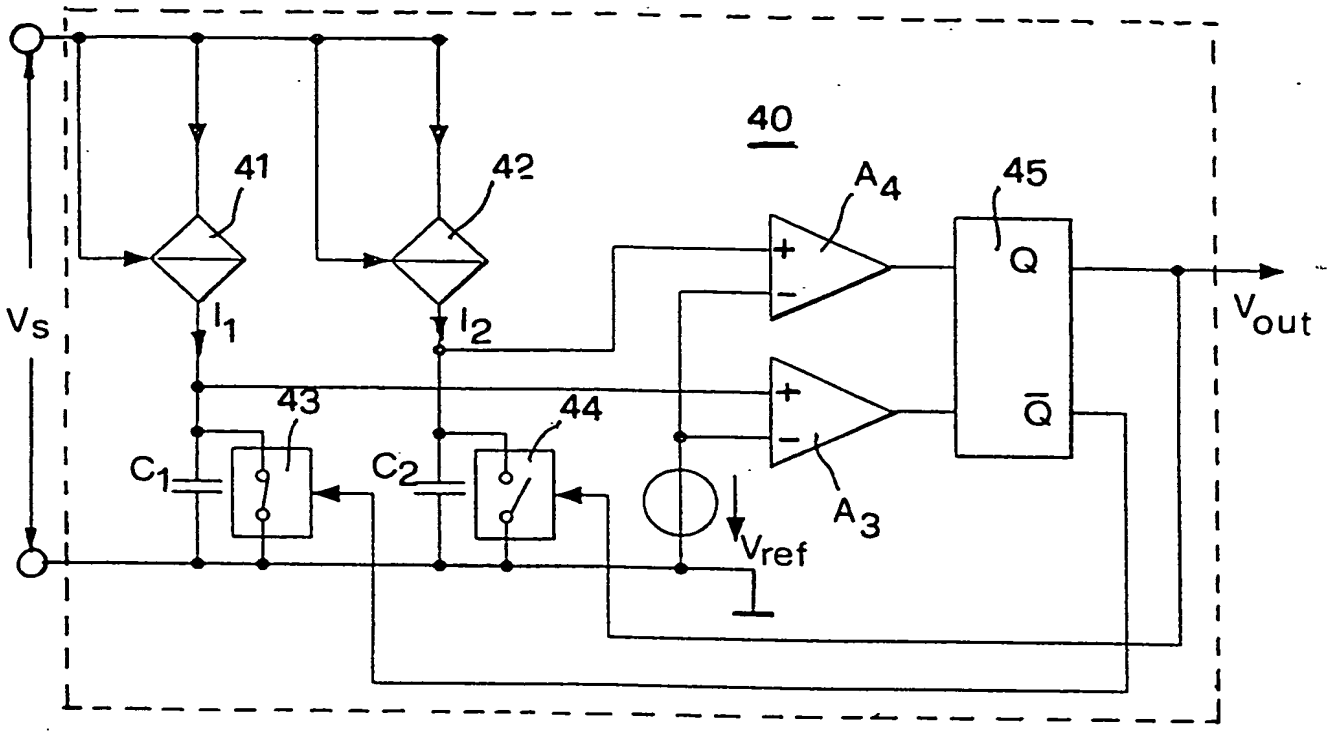

40
41
42
45
A4
Q
Q̄
Vout
Vs
I1
I2
43
44
C1
C2
A3
Vref

Fig. 3

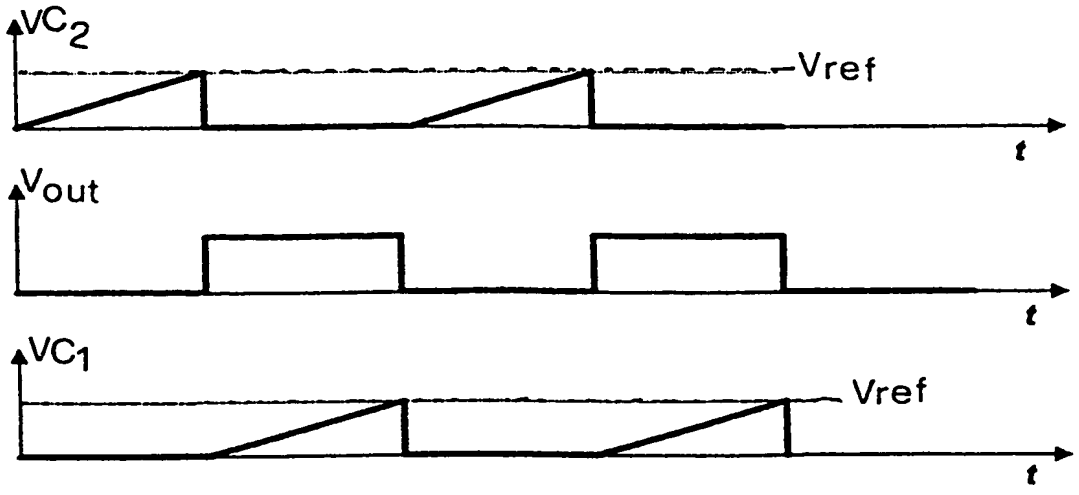

VC2
Vref
t
Vout
t
VC1
Vref
t

Fig. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 99/06674

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06K19/07 G06K7/10 G06K7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 89 01671 A (FORELICH RONALD W) 23 February 1989 (1989-02-23) abstract; figure 1	1
A	GB 2 287 544 A (AMPY AUTOMATION DIGILOG) 20 September 1995 (1995-09-20) abstract; figure 1	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 December 1999	11/01/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Cardigos dos Reis, F

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 99/06674

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 8901671 A	23-02-1989	US 4829166 A	09-05-1989
		AU 2384988 A	09-03-1989
		EP 0328631 A	23-08-1989
		JP 2500939 T	29-03-1990
GB 2287544 A	20-09-1995	GB 2259779 A	24-03-1993
		AU 652667 B	01-09-1994
		AU 2544492 A	27-04-1993
		AU 6602094 A	08-09-1994
		DE 604493 T	14-06-1995
		EP 0604493 A	06-07-1994
		ES 2058051 T	01-11-1994
		FI 935017 A	12-11-1993
		WO 9306493 A	01-04-1993
		GB 2286250 A,B	09-08-1995
		GR 94300076 T	30-11-1994
		HK 120796 A	19-07-1996
		JP 6510857 T	01-12-1994
		NO 940846 A	10-03-1994
		US 5450007 A	12-09-1995
		ZA 9207013 A	22-06-1993